THE CHALLENGE TO THE YOUNG SCIENTIST[1]

E. H. JOHNSON,
Kenyon College, Gambier, Ohio

In the present period of world-wide confusion it is difficult to trace the trends in human thinking and behavior that will prove dominant in the world of tomorrow. But undoubtedly we will agree at once that we are now entering a time of unprecedented need for all of the stabilizing influences that mankind has acquired during the centuries that are past.

Perhaps, first among these we should put the ethical and moral principles most clearly defined in Christianity, although it is true that there have been many other religions and philosophies which, though unacceptable to us, would, if universally followed, prevent any such mess as that in which most of the world is now involved. But however interesting these factors may be, the stabilizing agency to which I shall ask you to give a little thought this morning, is of much more recent development. I refer to the broad field of science.

The philosophies of science and religion have something in common. They both are systems for explaining the problems of existence. They are in agreement in that both presumably aim to be constructive. The true scientist does not have to be an atheist, and certainly he can not be a nihilist.

In contrast to religious or political arguments, all scientific questions can be settled or at least clarified by observation, calm and reasoned judgment, and unselfish thinking. And I believe that loyalty to these principles leads to loyalty to the governmental structure that fosters them. As a nation we are becoming involved in what may prove to be the greatest struggle of the ages, for it is between those who would fetter mind and body and those who would promote healthy growth. Each of us must decide which camp he will support. As scientists our choice should be an easy one to make, for science is necessarily democratic, and it requires an atmosphere of freedom if it is to survive, while the dictatorships are built on the principle of stifling freedom of thought and of action.

Now the scientific method demands a special kind of thinking, a habit of thought that will guide one's reasoning processes and actions. Science is more than a mere collection of facts; it is a philosophy of the universe. It means truth about existence. It is opposed to superstition. It has no room for wishful thinking. In the words of Bertrand Russell, "The kernel of the scientific outlook is the refusal to regard our own desires, tastes and instincts as affording a key to the understanding of the world."

It has been suggested that the scientific method is man's greatest discovery. We are still in the process of discovering it, for it implies a degree of discrimination that is far from common, even in so-called cultured circles. The word "science" comes from *scire*, to know, and its present meaning recalls another word, "sense," from *sensus*, to perceive. True perception leads to knowledge, or, as Francis Bacon expressed it, "knowledge is the daughter of experience, not of authority."

These facts are so well known to this audience that you smile at the mere mention of legislative bills proposing to make the value of "pi" equal to 3, or to aid aviation by repealing the law of gravity, but it is a sad fact that only a small part of the people in the world would see in these proposals anything to smile about. Surely, there is missionary work to be done. In fact, the task is so big, that I fear many generations of young scientists like yourselves will find it scarcely diminished. If progress is to be made, an aggressive campaign will be necessary;

[1]Annual Address, Junior Academy Section, The Ohio Academy of Science, Denison University, Granville, Ohio, April 18, 1942.

mere enthusiasm will accomplish little or nothing. But if you have acquired the scientific outlook, you will enjoy spreading the gospel of truth-seeking wherever you go, for you will be guided by scientific faith.

We will agree, then, I assume, that human progress is not to be advanced by mandate, and also that none of the worth-while qualities of civilization have been furthered by bullying.

It is quite generally admitted that the scientific method already has provided the possibilities for more comfort and happiness than now exist. Of course, there are a lot of people who must blame something or some one for all of the ills of the world. They see in technology only the tremendous forces that man has harnessed and turned to purposes of destruction. Now it should be quite evident, I think, that things in themselves are neither good nor bad; technology is neither moral nor immoral, it is amoral. Science means "sense," common sense (which, by the way, is far from common). But we *do* have to admit that a mere knowledge of the scientific way of life has not been sufficient to insure sane living. Unfortunately, the human machine has no built-in governor. Nevertheless, I believe that the potentialities for human betterment afforded by continued scientific progress, are practically without limit.

It may be that the suppression of the corrosive vandalism now spreading over the earth will necessitate a vast amount of additional destructiveness, but, unless we are ready to admit that life is only an ugly joke, and that we are foreordained from all time to be the victims of powers with purely malicious purposes, I see no reason to relinquish my own confidence in science and the scientific method as among the most promising agencies by which the world may be saved from a total relapse into barbarism. The outcome will depend entirely on the use mankind makes of the resources already within its grasp. You, who will be the scientists of the next few decades of the world's recovery and reconstruction, may actually be able to determine its course for centuries to come, for, as Anthony Eden has said, "from henceforth, *science* and statecraft must march together. Diplomacy, which has up till now, been the servant of higher strategy, must increasingly become the servant of science."

I could go on for a long time recounting the aspects of this thing we call "science." Perhaps each of us will best formulate for it his own definition, or, each of us may find it impossible to frame a definition that is sufficiently inclusive to be satisfactory. So let us take a moment to consider its major aspects about which we can agree.

Science requires co-operation. Its structure is based on consistency; it demands of its devotees, intellectual honesty; it trains them in the acceptance of realities; it kills superstition; it develops a critical mind that is not easily duped by gossip about nations or individuals; it is not something that can be monopolized by any man or group; it discourages the spread of inflamatory ideas; already it has increased the average span of human life; it is steadily developing new remedies for old ills and the new ones arising from the increasing complexities of inter-human relations; it is intolerant of mediocrity of thought or habit, but expands one's tolerance for the views of others; gradually it is strengthening man's grasp on the good things of life; in the long run, it is evolutionary, not revolutionary.

Scientific work always is connected directly or indirectly with human needs, and it is for this reason that it flourishes only in an atmosphere of freedom. The unique results of scientific discoveries are clearly evident when we compare them with those of military campaigns and political machinations. Undoubtedly the latter have some lasting and possibly beneficial effects, but it is only a matter of time before they may be undone and almost forgotten. As an example of this contrast, consider Napoleon's alteration of the map of Europe. It certainly was not permanent. On the other hand, Pasteur's researches continue to give new hope to millions who otherwise would perish miserably. Again, no one will

deny that there probably is a tremendous amount of activity in Germany at the present moment, and yet its constructive phases are largely for destructive purposes, and I venture to predict that the names of Bunsen, Helmholtz, Hertz, Koch and Ehrlich will be remembered gratefully centuries after the name of Hitler has been forgotten.

We need not linger long over a list of the tasks awaiting the men and women who are devoting their lives to the various specialized branches of science. All will share the urge to restore and raise higher than ever before the standards of living, to heal the wounds of the world, and enrich human life in what we hope will be a long, peaceful post-war period. Biologists will continue adding to our already considerable knowledge of life and death, health and sickness, and the innumerable factors in the plant and animal worlds will have an increasing bearing on man's future. The chemist will keep on adding to an endless list of new substances, foodstuffs and industrial materials. The past course of the physicist in learning to recognize and control the forces of nature, probably has set his feet on a long road of discovery of laws that will find vital application in all of the divisions of science. The psychologist will be able to point out many things concerning the behavior of the human animal that will make possible a helpful analysis of man's actions and enable him to avoid many of his past follies. The geologist readily admits that as yet we know only a little about the earth and its vast resources. His work is clear for decades to come. And it is the same with astronomy and mathematics and all of the arbitrary divisions of science including an ever-increasing number of specialized branches, many of which already have assumed the proportions of major subjects. In all of them there is more to be done, more to be learned, more reward to be gained.

Change has no merit in itself Sometimes the older things turn out to be the best. Science, like other constructive branches of human endeavor, must build on the acquisitions of the past. Life itself has been defined as a summation of experiences—one's own and the recorded experiences of others. Thus the richness of one's life is directly proportional to his appreciation of the world of which he is a part. If you question this assertion, just compare in your own minds for a moment the solitary confinement on a lonely island, say, of a Charles Darwin, with that of a similarly isolated person who has never acquired the enriching ability to see Nature in her manifold forms with an appreciation born of trained understanding.

This illustrates one of the chief functions of science in the school curriculum. It should enable one to enjoy an enlarged life because he has learned to keep the eyes of his mind open. Too many are like the woman, just returned from a trip through Europe, who was not sure whether she had been in Rome or not, because, as she explained, her husband had bought all of the tickets.

The attributes of a scientist may be summed up in two phrases—*conscious ignorance*, and *active curiosity* His rewards will depend on his *attitude* as well as on his *aptitude*. Although he, of all men, will find reasons for optimism, his life can never be one of complacency. "One must have chaos within," declared Zarathustra, "to enable one to give birth to a dancing star." In other words, he must be ever-mindful of the challenge awaiting him with each new dawn.

I hope that by this time each of you is asking himself: "What is the immediate challenge to me as an individual, and to the particular group gathered together here today?"

You are the productive scientists of tomorrow, the engineers, the laboratory technicians, the teachers, the men and women in whatever walk of life, who have acquired something of the scientific way of thinking. Some of you will be carrying on the work of the Senior Academies of Science in the years to come, not because it will bring you any money, but because you will be life-long true lovers of science. You may earn your bread and butter in ways not ordinarily classed as scientific,

but you will do your thinking scientifically, that is, with intellectual honesty, tolerance and altruism, because of the habits you now are forming as members of this Junior Academy of Science.

There is more truth than poetry in the statement that "as the twig is bent, so the tree will be inclined." In urging you to cling fast to the scientific way of life, I am not trying to sell anything, or advance any pet theory, for the cold facts add up to the single conclusion that this way of procedure has been constructive, while unscientific methods have been unproductive, if not actually destructive.

Junior Academies like this one, and science clubs in general, are apt to suffer during a period of world stress such as that we now are entering. In this sad respect they are no different from many organizations whose immediate aim is exclusively practical. Undoubtedly, the times ahead will try men's souls, and herein lies your greatest challenge, namely, to carry on for the sake of the brighter days that are sure to come, to enlist the co-operation of others for the good of the community life that must be reformed when the present destructive influences at last are subdued, to point the way of light and universal truth to a world half blinded by the smokes of its own burning temples.

Only a few years lie between today and the time when you will be called upon to be the scientific leaders, the legislators, the business managers, the teachers in a recuperating society. Whatever your political adherence, your church affiliation, your race, sex or physical characteristics, you cannot avoid the responsibility that will be thrust upon you, and I thoroughly believe that the course of the entire world may be influenced by groups such as this one, whose members have the courage to face the facts of life, the knowledge and honesty to use these facts for human betterment, and the intelligence to recall one of the real lessons of history, namely, that any other course has failed utterly to raise man above the level of the beasts of prey. And last, and most important of all, may you cherish the God-given sanity to realize unceasingly that yours is a trust. Your tools are sharp and two-edged, they may rebuild the world; they may destroy it. We who have been fortunate enough to gain a glimpse of how the world can be made a better place in which to live, must do all in our power to spread this gospel of constructiveness, to popularize the scientific attitude, in short, to take our places among the builders of the kind of world we want.

Please let me emphasize that in these remarks I am not for a moment advocating anything short of as well-rounded an education as may be obtainable. This is something to be pursued throughout life. It should include a generous appreciation of our rich heritage of culture in many fields. The scientist who has specialized in his chosen subject matter to the exclusion of the humanities is in as deplorable a state as the humanist who sees no cultural values in science. The educational process should be many-sided, for, in the words of Richard Gregory, education is the "deliberate adjustment of a growing human being to its environment." Now surely, training in the sciences provides an essential part of the equipment for this adjustment.

Under present war conditions, "education as usual" is no longer possible. This fact will complicate your own advanced scientific study. Discouraging delays will be unavoidable. But, inasmuch as you never will doubt the value of the constructive philosophy and practice of science, you will find that even the handicaps encountered in this distressing period, cannot make it other than a glorious experience. As time passes you will forget what your teachers have said in the classroom or laboratory. Perhaps you will not long remember that such a person as this or that particular teacher ever lived, but all the time your educational process has been going on, and its very essence is in the change it has produced internally in you as an individual. It is to be hoped that you have acquired a measure of healthy skepticism, a dominating and purposeful curiosity, a disciplined imagination, and the ability to meet and solve wholly new kinds of problems.

I believe that a fair degree of broad cultural training, including the sciences, is desirable in the development of a good citizen. We must cling to our knowledge of what constitutes decent standards for living with each other and the rest of the world, especially during this time of social and political turmoil. These ideals have been growing through the ages, and now, illuminated by the torch of science, they should help us to find the answers to the formidable questions with which we are confronted. If not, we will have to admit that we have been on the wrong track throughout the entire Christian Era.

If you scan the pages of social, political and military history, you will find in them principally a rather depressing account of mankind's mistakes and failures. But if you are seeking inspiration, you need only turn to the story of man as a builder, and this is largely contained in the history of his scientific growth and progress. Here is something that each of you can join in. Soon you will realize that you are a part of a long procession, headed by those humble creatures who first showed their fellows how to chip stone tools, and make fire, and construct shelters, and ultimately to build the roads that still are leading to new horizons. If you keep the faith you will be rewarded by ever-widening vistas of a land of great promise. And always, you will be in grand company.